University of California at Berkeley
Department of Physics
Physics 7A, Spring 1997

First Midterm, sections 1 and 2
February 25, 6:30pm to 8pm

You will be given 90 minutes to work this exam. One handwritten note sheet is permitted. You may use the numberical functions of a calculator, but please don't use anything more complicated than a square root. Your description of the physics involved in a problem is worth significantly more than any numerical answer. Show all work, and take particular care to explain what you are doing. Write your answers directly on the exam, and if you have to use the back of a sheet make sure to put a note on the front. Do not use a blue book or scratch paper.

Each of the first three problems is worth 20 points, divided as shown. The remaining short answer and multiple choice questions are worth a total of 40 points, divided as show.

Read the problems carefully.

Try to do all the problems.

If you get stuck, go on to the next problem.

Don't give up! Try to remain relaxed and work steadily.

NAME: _____

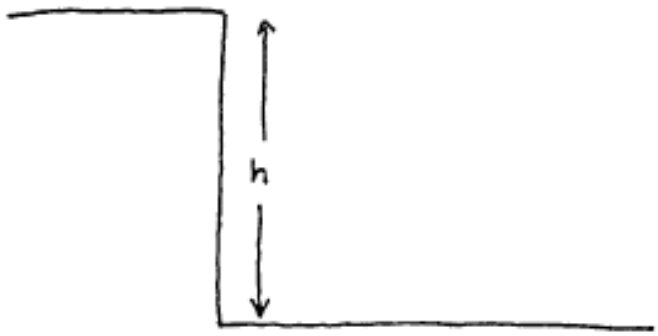
SID NUMBER: _____

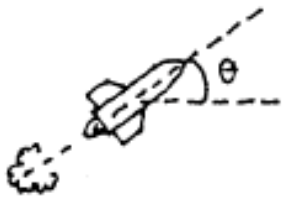
DISCUSSION SECTION NUMBER:_____

DISCUSSION SECTION DATE/TIME: _____

$\sin 45° = 0.707$, $\cos 45° = 0.707$, $\sin 30° = 0.500$, $\cos 30° = 0.866$

1)





You are standing on top of a cliff of height h (see left sketch). You have a cheap rocket of mass M which you are going to launch by positioning it at some angle θ to the horizontal, and then starting the motor (see right sketch). The rocket motor will generate a force (thrust) F for essentially forever, and the guidance system will hold the angle with respect to the ground constant. You can assume that $F < Mg$, so that the rocket cannot go straight up. Note that air friction is negligible, and that you do not throw the rocket.

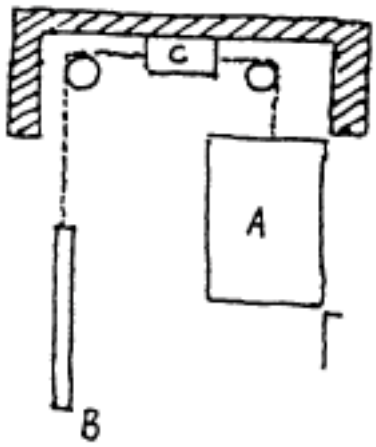
a) (2 pts) Draw a free body diagram for the rocket when launched at an angle $\theta = 30°$.

b) (4 pts) What are the horizontal & vertical accelerations of the rocket as a function of θ (and other variables)?

c) (6 pts) What are the horizontal & vertical positions of the rocket as a function of time? Make sure your signs and co-ordinate system are clear.

d) (6 pts) How far to the right does the rocket go before hitting the ground when launched at an angle θ?

e) (2 pts) Sketch the path of the rocket and explain your reasoning briefly.



2) Halliday, Resnick & Krane Chapter 5 problem 61:

An elevator consists of the elevator cage (A), the counterweight (B), the driving mechanism (C), and the cable and pulleys. The mass of the cage is 1000kg and the mass of the counterweight is 1400kg. Neglect friction and the mass of the cable and pulleys.

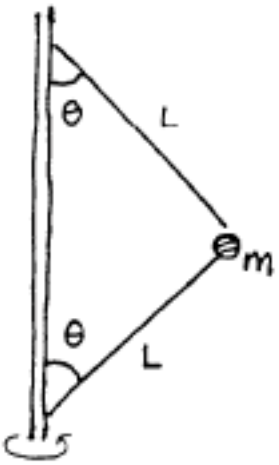
The elevator accelerates upward at rate $a = 2.30\ m/s^2$ and the counterweight accelerates downward at the same rate.

a) (5 pts) What is the tension in the cable supporting the elevator cage (T_A)?

b) (5 pts) What is the tension in the cable supporting the counterweight (T_B)?

c) (10 pts) What force is exerted on the cable by the driving mechanism?

3) A mass m is attached to a rigid vertical rod by means of two massless strings of length L, each making an angle of $\theta = 45°$ with the rod. The system is rotating about the axis of the rod n times per second, so that the mass is moving with speed 2π nL sin θ.



a) (2 pts) Draw a free body diagram for the mass m.

b) (4 pts) Calculate the net force on the mass. Specify the direction.

c) (4 pts) Find the tension in the lower string (T_{lower}).

d) (5 pts) Find the tension in the upper string (T_{upper}).

e) (5 pts) Is there a value for n below which the strings do not stay taut? If so, what is it?

4.1)(2 pts; choose one) Two steel balls, one of which weighs twice as much as the other, roll off of a horizontal table with the same speeds. In this situation:

a) both balls impact the floor at approximately the same horizontal distance from the base of the table

b) the heavier ball impacts the floor at about half the horizontal distance from the base of the table than does the lighter

c) the ligher ball impacts the floor at about half the horizontal distance from the base of the table than does the heavier

d) the heavier ball hits considerably closer to the base of the table than the lighter, but not necessarily half the horizontal distance

e) the lighter ball hits considerably closer to the base of the table than the heavier, but not necessarily half the horizontal distance

4.2)(2 pts; choose one) A large truck breaks down out on the road and receives a push back into town by a small compact car. While the car, still pushing the truck, is speeding up to get to crusing speed:

a) the amount of force of the car pushing against the truck is equal to that of the truck pushing back against the car.

b) the amount of force of the car pushing against the truck is less than that of the truck pushing back against the car.

c) the amount of force of the car pushing against the truck is greater than that of the truck pushing back against the car.

d) the car's engine is running so it applies a force as it pushes against the truck but the trucks engine is not running so it can't push back against the car, the truck is pushed forward simply because its in the way of the car

e) neither the car nor the truck exert any force on the other, the truck is pushed forward simply because its in the way of the car

4.3)(2 pts; choose one) An astronaut on the moon simultaneously drops a feather and a hammer. The fact that they land together shows that:

a) no gravity forces act on a body in a vacuum

b) g on the moon is less than g on the Earth

c) in the absence of air resistance all bodies at a given location fall with the same acceleration

d) the feather has a greater weight on the moon than on the Earth

e) G = 0 on the moon

4.4) (9 points total; Circle one of the three choices in each part) Two stones are released from rest at a certain height, one after the other.

(a) Will the difference in their speeds increase, decrease, or stay the same?

(b) Will their separation distance increase, decrease, or stay the same?

(c) Will the time interval between the instants at which they hit the ground be smaller than, equal to, or larger than the time interval between the instants of their release?